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Forest Pest Management Report

R-3 84-5

BIOLOGICAL EVALUATION
Western Spruce Budworm

Santa Fe National Forest
Jemez Indian Pueblo,
and Santa Clara Indian Pueblo
New Mexico

December 1983

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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
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ABSTRACT

Western spruce budworm, Choristoneura occidentalis Free., infestations on the Jemez Division of the Santa Fe National Forest and adjoining lands of mixed ownership continued in 1983. A total of 118,256 acres of defoliation, as detected by aerial survey, was recorded in 1983. Defoliation was aerially detected on the Mesas entomological unit for the first time in 1983. Average egg mass densities stayed at the same levels as in 1982 in most entomological units. Moderate defoliation is expected to continue on most entomological units in 1984, barring unforeseen mortality factors, such as inclement weather.

INTRODUCTION

Western spruce budworm (WSBW), Choristoneura occidentalis Free., continued to defoliate mixed conifer stands on the Santa Fe National Forest (NF) in 1983. Defoliation visible by aerial survey was first reported on the Jemez East and Jemez West entomological units in 1976, on the Jemez Central entomological unit in 1977, and on the Mesas entomological unit in 1983. The Jemez Spray entomological unit was aerially treated with carbaryl in 1977.

Egg mass surveys were conducted on six entomological units. Results and management alternatives are presented.

TECHNICAL INFORMATION

Insect. Western spruce budworm, Choristoneura occidentalis Freeman

Hosts. Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History. The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobile.

2. Mature larvae consuming current year's needles.

3. Shoots webbed together by larvae.

4. Webbed shoots turning brown and falling from trees.

5. Defoliation most evident in upper crowns of trees.

6. Trees dying from the top downward after several years of heavy defoliation.

Extent of Defoliation in 1983. Defoliation was observed by aerial detection surveys on 118,256 acres of the Santa Fe NF and adjoining lands in the Jemez Mountains. Excluding the Baca Location, acres of defoliation by intensity class were: Light, 25,000 acres; moderate, 72,100 acres; and heavy, 8,300 acres. Figures 1 through 5 show the extent and intensity of defoliation.

BIOLOGICAL INFORMATION

Methods. Egg mass surveys were conducted in August to estimate defoliation in 1984. Two branches (70 cm in length) were cut from opposite sides of the midcrown of three sample trees on plots located in each of the entomological units. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30 to 50 feet in height; relatively open grown with a full crown; and some budworm feeding evident, but not severely defoliated or top-killed. Each branch was individually bagged in cloth sacks, tied securely, labeled, and transported to a laboratory for examination. Foliage was stored in a walk-in cooler at about 40° F until examined.

In the laboratory, foliage was examined under ultraviolet light for egg masses. Needles with egg masses were classed as from current year's foliage or a previous year's foliage and kept separate in labeled pill boxes. New and old egg masses were separated by an experienced laboratory technician. All egg masses on current year's foliage were classed as new and their characteristics formed the basis for aging egg masses found on previous year's foliage.

Defoliation estimates for 1984 were determined from the density of 1983 egg masses using the following information presented by McKnight et al. (1970):

Egg mass density[a]	Predicted defoliation class[b]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations

Egg mass density[a]	Predicted defoliation class[b]
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a]Number of egg masses per square meter of foliage.
[b]Defoliation class limits (percent of new growth).
Undetectable = <5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = >65 percent

RESULTS

The Forest has been divided into entomological units that generally conform with the analysis units in the Draft Environmental Impact Statement (DEIS), Western Spruce Budworm Management Program, Santa Fe National Forest, that was issued in April 1983. Future use of the term analysis unit is in reference to this publication.

The extent of the infestation decreased from 187,600 acres on the Santa Fe NF and adjoining private lands in 1982 to 118,256 acres in 1983. The severity apparently increased, however. Defoliation figures and intensities from aerial surveys reflect cumulative defoliation to an extent. The results of the egg mass survey are discussed by entomological units below and are summarized in table 1.

Jemez East Entomological Unit. This unit consists of parts of the Jemez, Espanola, and Tesuque Ranger Districts and the Santa Clara Pueblo Indian Reservation. The entomological unit is the Los Alamos and Peralta analysis units from the DEIS combined. Egg masses per square meter of foliage dropped from 39.4 in 1982 to 22.2 in 1983. Total acreage defoliated was 25,200 in 1983 (figure 1), one-half the acreage defoliated in 1982, 50,420 acres. Defoliation is expected to continue in the same areas again in 1984 at moderate levels. Permanent tree damages, specifically top-kill and mortality, are expected to increase in severity on the smaller size classes in 1984.

Jemez West Entomological Unit. This unit consists of parts of the Jemez, Coyote, and Cuba Ranger Districts and consists of the DEIS Rio de las Vacas and San Pedros analysis units. Egg masses per square meter of foliage stayed at the same relative level, 29.2 in 1983 and 28.8 in 1982. Acres defoliated decreased from 101,035 in 1982 to 62,150 in 1983 (figure 2). Defoliation occurred in the same general areas. The majority of defoliation was in the moderate intensity class in 1983.

Defoliation is expected to continue at moderate levels in 1984. However, defoliation is expected to be more intense on the north and northeast sides of the San Pedros Parks Wilderness Area. Permanent tree damages are occurring in the above-mentioned area and the Barley

Canyon, Fenton Lake, and Schoolhouse Mesa areas where heavy defoliation has occurred for a number of years on the north aspects of ridges running east-west. A damage survey in the Cecilia Springs area, north of the San Pedros Parks Wilderness, has shown that top-kill and mortality of white fir and Douglas-fir have occurred; nearly all of the trees in some white fir stands have been killed. A separate report will be prepared on this survey.

Jemez Spray Entomological Unit. This unit consists of parts of the Cuba Ranger District and the Jemez Pueblo Indian Reservation, and is part of the DEIS Rio de las Vacas analysis unit (figure 3). This unit is considered seperately from the Jemez West entomological unit because it was sprayed with carbaryl for WSBW control in 1977 (Parker et al. 1980). Egg masses per square meter of foliage increased from 13.3 in 1982 to 20.6 in 1983. Acreage defoliated decreased from 17,500 in 1982 to 15,900 in 1983. The intensity of defoliation increased from primarily light to primarily moderate.

The 1977 treatment kept budworm population levels low for 5 years. The populations, as measured by egg mass densities, in the treated and untreated areas are now approximately equal. Tree damages may begin within the next 2 to 3 years. The results of monitoring the effects of the 1977 spray project for a sixth year will be discussed in an upcoming report.

Jemez North Entomological Unit. This unit consists of parts of the Espanola Ranger District and is basically the same as the DEIS Abiquiu analysis unit (figure 4). Egg masses per square meter of foliage increased from 19.3 in 1982 to 24.8 in 1983. Defoliation decreased from 14,430 acres in 1982 to 2,000 acres in 1983. Defoliation in 1983 was in the same areas as 1982, only greatly reduced.

In 1982, defoliation was predicted to increase in 1983, although egg mass densities had dropped, as has occurred in other entomological units. The extent of defoliation should remain at the same level or increase slightly. Permanent tree damages are expected to be minimal as long as the population stays at the current level.

Mesas Entomological Unit. This unit consists of part of the Coyote Ranger District and is the same as the DEIS Mesas analysis unit. Egg masses per square meter of foliage was 8.3. Defoliation was detected on 150 acres in 1983 (figure 5).

This is the first year that defoliation has been detected by aerial survey on this unit. Very light defoliation was detected over a larger area during the egg mass survey. Egg mass samples were collected throughout the entomological unit.

Defoliation is not expected to increase substantially in 1984. However, the area visibly defoliated from the air in 1983 may expand. The Mud Springs, Cow Creek, Tesuque, Pecos, and Las Vegas analysis units were not sampled since no budworm defoliation was detected during the aerial detection survey.

MANAGEMENT ALTERNATIVES

Management alternatives for the WSBW are discussed in detail in the Western Spruce Budworm Management Program, Santa Fe NF, DEIS. The following alternatives are a summary of those in the DEIS.

No Action. No action is taken to suppress the budworm infestation or to silviculturally reduce stand susceptibility to future outbreaks. Salvage of heavily damaged commercial timber may become necessary.

Effects of this alternative are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damages resulting from the WSBW in the Southwest are not completely known, damages similar to those estimated for the northern Rockies could occur if the outbreak continues unabated. These include the following:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree quality loss	90+

2. Costs associated with this alternative will be the value of the resources damaged. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation. Social impacts will result from the resource damage, although their dollar value is largely intangible.

Direct Suppression. Suppression actions are taken against the current infestation. Direct suppression may be: (1) Aerial application of insecticides against the entire infestation or on selected entomological units and/or stands; and (2) protection of individual high-value trees with insecticides.

Insecticides registered by the U.S. Environmental Protection Agency for use against the budworm are:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe NF was successfully suppressed in 1977, and the outbreak has remained at a low level for 5 years (Telfer 1983). Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene Forest Spray (acephate) is a nonpersistent insecticide registered for use against the WSBW and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest. Without further pilot testing in the Southwest, it is not recommended.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the WSBW. However, it is not recommended because it has yielded inconsistent results during past suppression projects.

4. Mexacarbate (carbamate insecticide)

Mexacarbate (Zectran) is a nonpersistant pesticide which is available for use against the WSBW. Mexacarbate is applied at a rate of 0.15 pounds of active ingredient per acre. No lasting environmental effects have been identified when properly applied at this rate. Mexacarbate has never been used against the WSBW in the Southwest; pilot testing the efficacy of this insecticide is recommended before operational use.

5. Microbial Insecticides

Bacillus thuringiensis (B.t.), a bacterium, has been used experimentally and operationally in the Southwest. Results have shown that good WSBW larval mortality can result; however, results can be highly variable. Thus, it is recommended that current formulations be used only in sensitive areas (for example, populated areas and stream courses) where chemical insecticides may not be acceptable.

Effects of this alternative are:

1. Aerial application of insecticides

a. Tree damages prior to treatment are accepted and may reduce the benefits of treatment, but further, more serious losses will be prevented. Serious defoliation may be prevented for up to 5 years after treatment.

b. Excessive losses to the timber and visual quality resources will be prevented.

c. Cost of this alternative is approximately $9 per acre.

d. Proper use of any of these insecticides will not pose a significant hazard to humans, wildlife, or the environment.

2. Treatment of high-value trees

a. Treated trees would be protected from defoliation.

b. Annual applications of an insecticide would be required during the outbreak, since the treated trees would be reinfested from nearby infested stands.

c. Application costs would be relatively low and cost effective.

d. Timber and visual quality resources will suffer losses.

e. Proper use of any of these insecticides will not pose a significant hazard to humans, wildlife, or the environment.

Silvicultural Management. This alternative is the silvicultural manipulation of the mixed conifer type to create stand conditions that reduce the impact of future infestations. This alternative has no effect on the current infestation. Silvicultural prescriptions for mixed conifer stands should emphasize "state-of-the-art" strategies for reducing stand budworm vulnerability/susceptibility. These strategies include: (a) Regeneration cuts designed to create more even-aged stands, with a lower percentage of true fir; (b) regeneration cuts with artifical regeneration of nonhost tree species; (c) intermediate cuts, such as thinning, improvement, and sanitation, to increase stand vigor, regulate stocking, and favor nonhost tree species; and (d) use of the above strategies to create a mosaic of different age class, even-aged stands.

Effects of this alternative are:

1. Impacts of future infestations may be reduced.

2. Overall, treated stands will be more vigorous and better able to withstand the impact of most pest organisms.

RECOMMENDATIONS

Silvicultural management is recommended for all mixed conifer stands in commercial timber production on all of the entomological units.

In 1984, no action is recommended for all mixed conifer stands not in commercial timber production on all entomological units.

Direct suppression is not recommended for any analysis units in 1984. Direct suppression is not a viable alternative for the Jemez East, Jemez West, and Jemez North entomological units because permanent tree damages have already occurred. Direct suppression is not recommended for the Jemez Spray entomological unit because budworm populations are high, some permanent tree damages have occurred, and treatment without treating the Jemez West entomological unit will not likely give lasting results. Direct treatment is not recommended for the Mesas entomological unit, although a budworm infestation was detected in 1983, because the infestation is small and the population is currently at a low level. Direct suppression is not recommended for the Mud Springs and Cow Creek entomological units because there are no infestations currently.

These recommendations are consistent with the proposed alternative in the Draft Environmental Impact Statement, Western Spruce Budworm Management Program, Santa Fe NF.

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TABLE 1.--Summary of the egg mass density and aerial detection surveys on the Jemez East, West, Spray, and North entomological units, Santa Fe National Forest, 1981

Jemez East entomological unit										
		1976	1977	1978	1979	1980	1981	1982		1983	
								$\bar{x}$	SE	$\bar{x}$	SE
New egg masses/ sq. meter foliage		16.9	12.7	12.1	18.9	58.3	30.4	39.4	8.6	22.2	2.9
Buildup ratio		---	0.7:1	0.9:1	1.6:1	3.1:1	0.5:1	1.3:1		0.7:1	
Actual defoliation (acres)	L	2,520	55,872	3,309	1,638	22,880	15,200	12,810		4,575	
	M	2,440	1,556	503	512	18,635	39,200	27,115		19,950	
	H	0	0	0	0	2,560	3,300	10,495		675	
	TOTAL	4,960	58,428	3,812	2,150	44,075	57,700	50,420		25,200	

Jemez West entomological unit										
		1976	1977	1978	1979	1980	1981	1982		1983	
								$\bar{x}$	SE	$\bar{x}$	SE
New egg masses/ sq. meter foliage		---	4.3	6.1	9.7	44.2	21.4	28.8	7.0	29.2	1.8
Buildup ratio		---	---	1.4:1	1.6:1	---[1]	0.5:1	1.4:1		1.0:1	
Actual defoliation (acres)	L	0	435	512	716	7,370	12,810	51,700		15,375	
	M	0	589	418	0	7,885	30,000	42,010		41,200	
	H	0	0	0	0	3,610	8,600	7,325		5,575	
	TOTAL	0	1,024	930	716	18,865	51,410	101,035		62,150	

[1] Not directly comparable to 1979 due to a change of entomological unit boundaries, see Telfer, 1981.

TABLE 1.--Summary of the egg mass density and aerial detection surveys on the Jemez East, West, Spray, and North entomological units, Santa Fe National Forest, 1981--Continued

Jemez Spray entomological unit										
		1976	1977	1978	1979	1980	1981	1982		1983	
								$\bar{x}$	SE	$\bar{x}$	SE
New egg masses/ sq. meter foliage		12.6	1.7	0.5	0.6	4.9	6.1	13.3	1.8	20.6	6.9
Buildup ratio		---	0.1:1	0.3:1	1.2:1	8.2:1	1.2:1	2.2:1		1.6:1	
Actual defoliation (acres)	L	8,400	1,894	0	486	4,500	1,025	11,490		3,150	
	M	3,800	218	0	563	1,460	8,775	4,875		10,700	
	H	240	0	0	0	0	325	1,135		2,050	
	TOTAL	12,440	2,112	0	1,049	5,960	10,125	17,500		15,900	

Jemez North entomological unit						
		1981	1982		1983	
			$\bar{x}$	SE	$\bar{x}$	SE
New egg masses/ sq. meter foliage		51.3	19.3	4.6	24.8	16.0
Buildup ratio		---	0.4:1		1.3:1	
Actual defoliation (acres)	L	3,300	9,825		0	
	H	1,775	4,105		1,750	
	H	775	500		250	
	TOTAL	5,850	14,430		2,000	

TABLE 1.--Summary of the egg mass density and aerial detection surveys on the Jemez East, West, Spray, and North entomological units, Santa Fe National Forest, 1981--Continued

		Mesas entomologcial unit	
		1983	
		$\bar{x}$	SE
New egg masses/ sq. meter foliage		8.3	2.0
Buildup ratio		---	
Actual defoliation (acres)	L	150	
	M	0	
	H	0	
	TOTAL	150	

L = Light
M = Medium
H = Heavy

FIGURE 1.-- Extent and severity of WSBW defoliation, Jemez East entomological unit, Santa Fe NF, 1983

Entomological unit boundary

WSBW defoliation

L = Low
M = Moderate
H = High

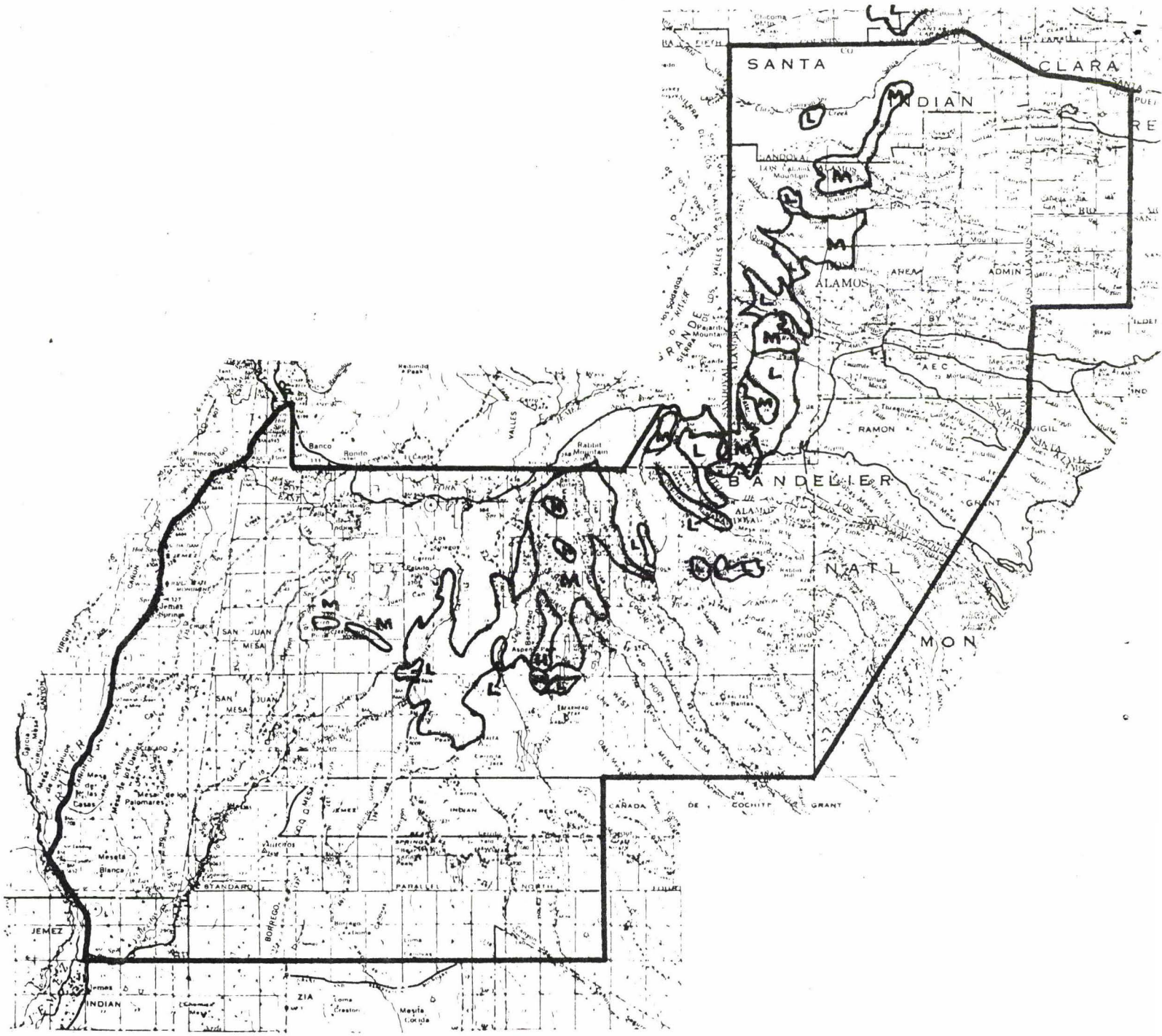

FIGURE 2.--Extent and severity of WSBW defoliation, Jemez West entomological unit, Santa Fe NF, 1983

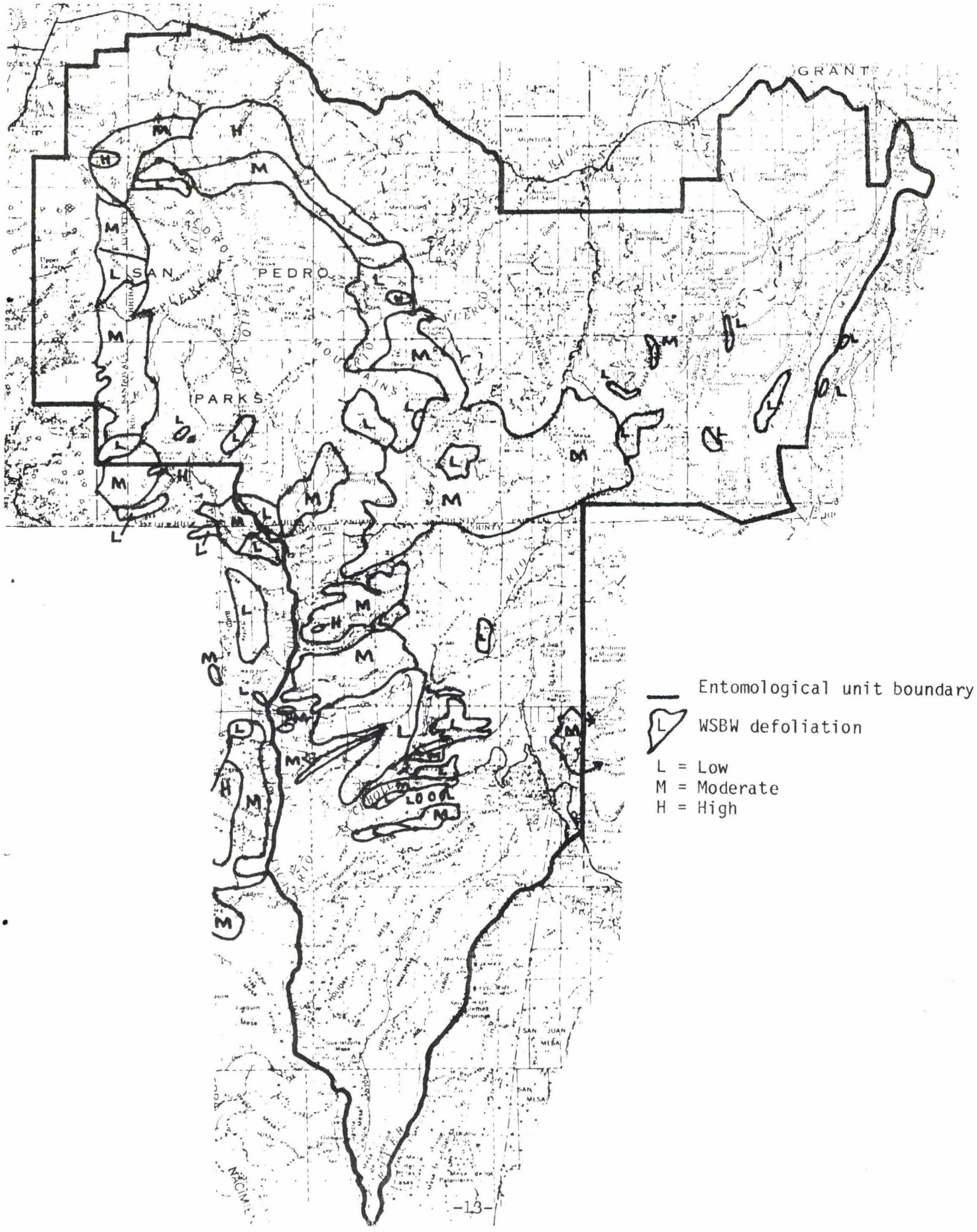

FIGURE 3.--Extent and severity of WSBW defoliation, Jemez Spray entomological unit, Santa Fe NF, 1983

Entomological unit boundary

L WSBW defoliation

L = Low
M = Moderate
H = High

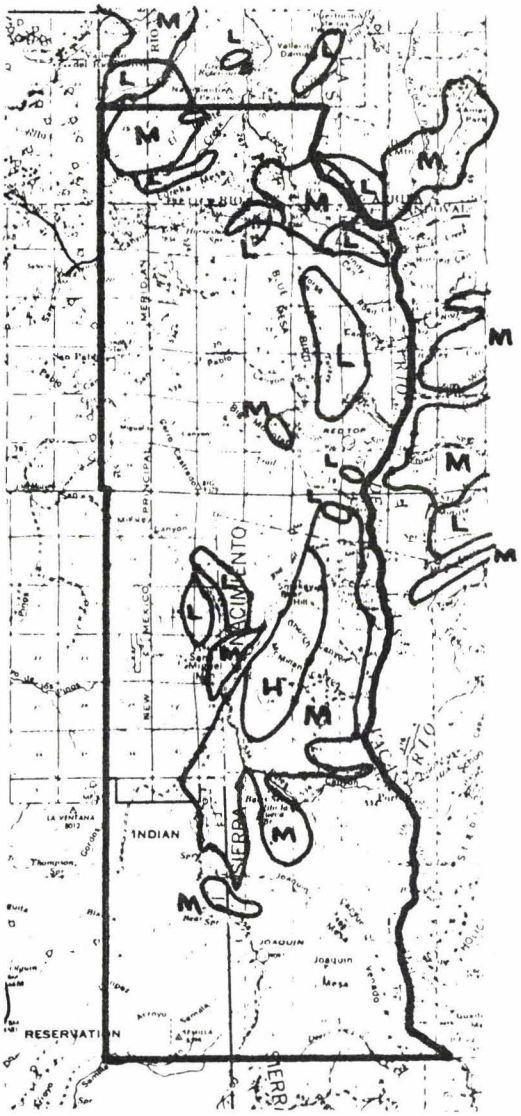

FIGURE 4.--Extent and severity of WSBW defoliation, Jemez North entomological unit, Santa Fe NF, 1983

Entomological unit boundary

WSBW defoliation

L = Low
M = Moderate
H = High

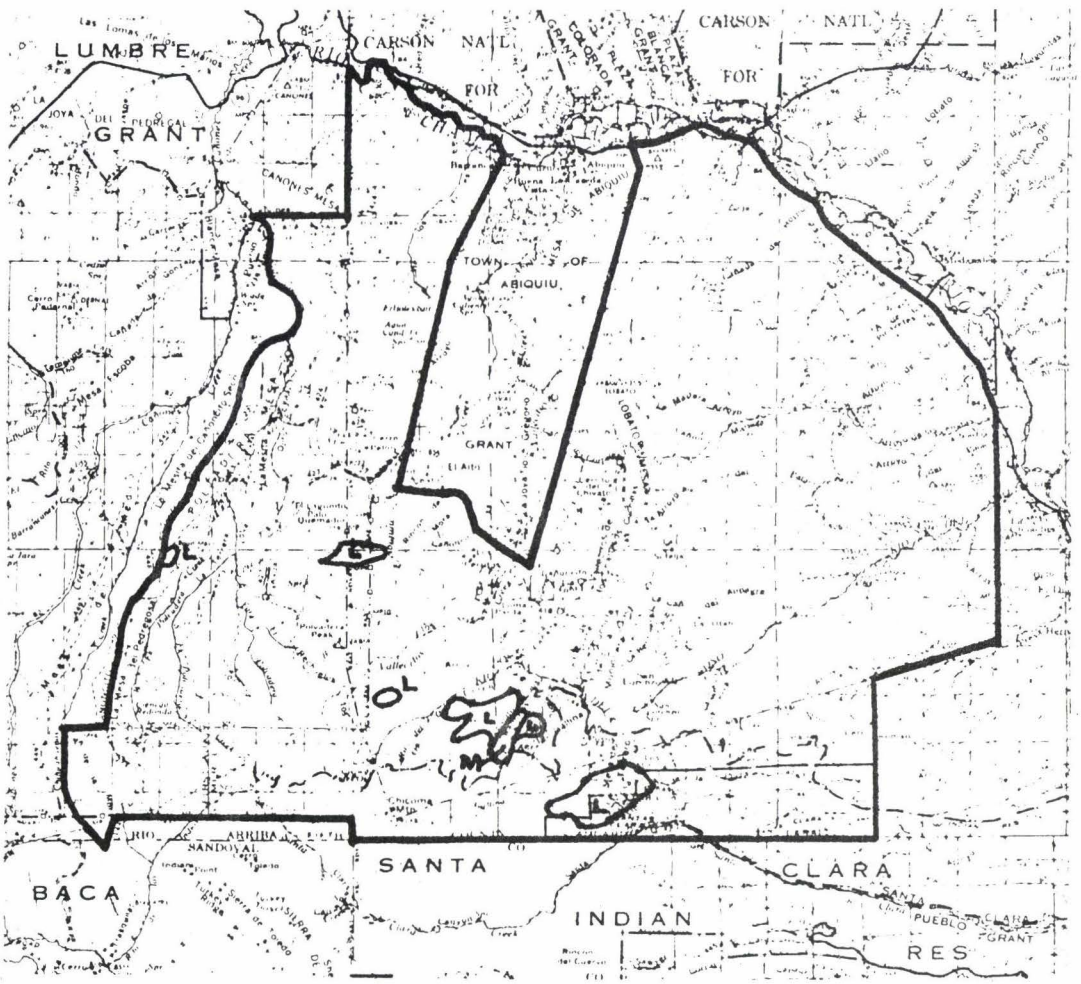

FIGURE 5.--Extent and severity of WSBW defoliation, Mesas entomological unit, Santa Fe NF, 1983

Entomological unit boundary

L WSBW defoliation

L = Low
M = Moderate
H = High